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9/22/98



22 September '98

Mark Dowiak, P. E.
Radian International, LLC
Penn Center West
Building III, Suite 300
Pittsburgh, PA 15276

Sent Via Fax

Re: Enviro-Chem RRA
Design Change Request for RCRA Compliant Cap

Dear Mark,

Attached is the design change request for the RCRA Compliant Cap that we have been discussing. The change request has been reviewed by the Trustees and Ron Hutchens and incorporates everyone comments.

As you aware, the Trustees have authorized the purchase of the 60 mil HDPE liner, and the construction of the bridge lift is starting today. Anything you can do the expedite getting this into USEPA's and IDEM's hands will assist us completing the field work before the freezing weather.

Thanks for all your help in getting this together. If you have any questions, please call.

Very truly yours,

A handwritten signature in black ink, appearing to read "G. J. Anastos", written in a cursive style.

G. J. Anastos, Ph.D., P.E.
Program Manager

attachment

cc: R Ball
N Bernstein
C Gaffney
R Hutchens

DESIGN FIELD CHANGE REQUEST
DFCR NUMBER _____

ENVIRO-CHEM SUPERFUND SITE
REMEDIAL ACTION
ZIONSVILLE, INDIANA

REFERENCE DATA

Date: 9-22-98

Specifications: 02200	Title: EARTH WORK	Page No.: 13 to 17
Drawing No.: c-11 c-5, c-6, c-7, c-9, c-10	Entitled: RCRA COMPLIANT COVER	
Sketch No.: sketchL9809100 Versar revision 1	Dated: 9-22-98	Entitled: HDPE CAP

DESCRIPTION

- Detailed Identification of Problem:
Alternative RCRA compliant cap
- Detailed Solution Proposed or Accomplished:

See attached change request
- Is the Problem and Isolated Case or General:

N/A
- Submit Sketches as Necessary:

Attached

Request By: GJ ANASTOS / <i>[Signature]</i>	Titles: contractor's PM
Approved By:	Titles:
Distribution:	1. Contractor's Project Manger 2. Contractor's CQC Manager 3. Design Engineering Manager 4. Trustees Site Engineer 5. EPA Site Representative

PRELIMINARY 9-22-98

*Enviro-Chem RRA
Design Change for RCRA Compliant Cap
Page 1*

Versar, Inc. (Versar) has performed Value Engineering on the installation of the RCRA compliant cap for the Northern and Central SVE Treatment Areas (approximately 127,400 square feet). Versar recommends the substitution of a textured 60-mil HDPE liner system (see attached Versar Drawing No. L9809100) for the clay cap, which would be an equivalent RCRA cap. The use of the HDPE liner system will mitigate the following problems that have been encountered:

- The marginally acceptable quality of the borrow pit material has hindered our ability to meet permeability requirements without compacting the Southern Concrete Pad (SCP) area excavated soil slated for Soil Vapor Extraction (SVE). The additional working of this borrow pit material to meet RCRA compliant cap requirements would result in the compaction of the excavated soils slated for SVE treatment. Compaction of the soils slated for treatment would slow, if not prohibit, the effective SVE treatment of this material.
- The wet and soft/fluffy conditions of the material placed in the north fill area for SVE treatment. The moisture content of this material was higher than anticipated and the discing of the material to break-up the clumps left this material difficult to compact.
- Pervasiveness of stones greater than one inches in diameter in the borrow pit material would require the use of expensive pre-screening to meet permeability/compaction requirements.
- The onset of cold weather (frost) will complicate our ability to compact the borrow pit material to meet the RCRA compliant cap requirements.
- The use of the HDPE liner will eliminate the need for a second stage, two cover system in the North and Central SVE treatment areas.

Versar will utilize the same type of HDPE liner (60-mil) installed on the north end of the SCP area and utilize Radian Specifications No. 02281 and 02282 (see Attachment 1) for QA testing and will follow the requirements in Versar's Construction Quality Control Plan (CQCP) Section 4.3 for installation and testing (see Attachment 2). An off-site testing laboratory will be utilized for all destructive testing of material and seams.

The proposed construction sequence for the 60-mil HDPE installation (by Taylor Construction, the same subcontractor that installed the previous 60-mil liner on the north end of the SCP area) follows:

1. Versar will construct a 6" to 12" deep bridging lift over the entire north and central SVE treatment areas, using suitable fill from the borrow pit area. All stone 2" or greater in size will be removed by hand and discarded from the capped area. The bridging lift will be rolled

with a smooth vibrating roller. The slope of the bridge lift, as shown on Versar Drawing No. L9809100, follows the same slopes identified in the original Radian Drawings for this area.

2. Versar will construct a 2' x 2' anchor trench in the existing keyway and backfill with select fill from the borrow pit area after the liner installation.
3. A HDPE 60-mil liner will be provided and installed (by Taylor Construction) on the north and central areas. The HDPE Liner material (see Attachment 3) will be the same material supplied by National Seal Company and installed between the central area and the north end of the former SCP area. A HDPE panel layout will be prepared and submitted to the Engineer for approval prior to the liner installation. All field seams will be tested in the field using air pressure tests. In addition, vacuum box testing of extrusion welds will occur to Radian's specifications.
4. A one sided Geonet material (National Seal Company's TEX-NET) will be installed on the top of the HDPE Liner. TEX-NET is a composite geonet comprised of National Seal Company's Polynet 3000, laminated on one-side with Hoechst Celanese Trivira 1125 Geotextile (see Attachment 3). The geonet will be tied at a maximum spacing of five feet using a prayer stitch seam.
5. A 18-inch deep lift of suitable material will then be placed on top of the Geonet material. All stone 2-inch or greater in size will be removed by hand and discarded from the capped area. The 18-inch deep suitable material lift will be rolled with a smooth vibrating roller, for compaction to a modified proctor of 85.
6. Six inches of topsoil will then be installed, and any stones 2" or larger will be hand picked and discarded.
7. The entire area will then have grass seed installed (by hydro-seeding) per the Radian specification.

After the completion of SVE treatment (approximately two years or less), as determined by start-up spike testing, Versar recommends the following sequence for final performance testing of the capped area.

1. USEPA will identify 20 locations that they want to sample to Versar.
2. Versar will remove topsoil, grass and 18-inches of suitable material from an area 4 ft x 4 ft. This material will be set off to the side of the excavations.

3. Taylor Construction, Versar's subcontractor who installed the original HDPE liner, will come in and cut and remove approximately a 12-inch square piece of Geonet and HDPE material at the locations selected by USEPA.
4. USEPA will then sample. Any drill cuttings will be placed on a piece of Visqueen next to the hole. A mix of Bentonite with the soil will be utilized to fill the bore hole.
5. Taylor Construction will repair the HDPE Liner and Geonet as specified in Radian's specification No. 02281 and No. 02282.
6. The 18-inch suitable fill and 6-inch top soil lifts will be repaired and reseeded by Versar.

Attachment 1
Radian Specifications Nos. 02281 and 02282

DIVISION 2 - SITE WORK

SECTION 02281 - HIGH DENSITY POLYETHYLENE LINER

(Rev. 1, 2/7/97)

PART 1 - GENERAL

1.01 SCOPE

- A. The Contractor shall provide all labor, materials, and equipment necessary to supply, install, field seam, and test 60-mil high density polyethylene (HDPE) within the concrete pad excavation area. All materials used shall meet the requirements of these Specifications, and all work shall be performed in accordance with the procedures provided herein and with all project lines, grades, cross sections, and dimensions shown on the Drawings.

1.02 RELATED SECTIONS

- A. Section 01300 - SUBMITTALS
- B. Section 02200 - EARTHWORK
- C. Section 02205 - SHEET PILE CUTOFF WALL
- D. Section 02280 - GEOTEXTILES

1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM D638 - Test Method for Tensile Properties of Plastics.
 - 2. ASTM D746 - Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - 3. ASTM D751 - Test Method for Coated Fabrics.
 - 4. ASTM D792 - Test Method for Specific Gravity and Density of Plastics by Displacement.
 - 5. ASTM D1004 - Test Method for Initial Tear Resistance of Plastic Film and Sheeting.

6. ASTM D1204 - Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
7. ASTM D1238 - Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
8. ASTM D1505 - Test Method for Density of Plastics by the Density-Gradient Technique.
9. ASTM D1603 - Test Method for Carbon Black in Olefin Plastics.
10. ASTM D1693 - Test Method for Environmental Stress Cracking of Ethylene Plastics.
11. ASTM D3015 - Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.

B. Federal Test Method Standards (FTMS):

1. FTMS, Number 101C, Method 2065 - Test Method for Puncture Resistance (1/8 Inch Probe).

1.04 SUBMITTALS

A. The Contractor shall submit the following under the provisions of Section 01300 - SUBMITTALS:

1. Product Data:
 - a. Geomembrane field panel layout plan and pipe penetration details.
 - b. Manufacturer's descriptive literature and specifications covering the product specified, including installation information.
2. Certificates of Conformance:
 - a. Manufacturer's certification that the 60-mil HDPE liner will be manufactured in accordance with specified reference standards.
3. Product Samples:
 - a. A representative sample of the 60-mil HDPE liner suitable for testing.

PART 2 - PRODUCTS

2.01 HDPE LINER

- A. The HDPE geomembrane shall be manufactured of new, first-quality products designed and manufactured specifically for the intended purpose.
- B. The HDPE liner material shall be so produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.
- C. The resin used in manufacturing the HDPE liner shall meet the following minimum requirements:

Property	Test Method	Unit	Value
Density	ASTM D792/D1505	g/cc	0.940
Melt Flow Index	ASTM D1238	g/10 minutes	≤0.492

- D. Reclaimed polymer shall not be added to the resin.
- E. The HDPE liner shall be 60-mil DURA SEAL HDPE as manufactured by the National Seal Company or Engineer approved equal. The HDPE liner shall meet or exceed the following minimum average roll value (MARV) properties:

Property	Test Method	Units	MARV
Thickness	ASTM D751, NSF Mod.		
Average		mils	60
Lowest Individual Reading		mils	57
Carbon Black Content	ASTM D1603	percent	2 to 3
Carbon Black Dispersion	ASTM D3015, NSF Mod.	rating	A1, A2, or B1
Tensile Properties	ASTM D638, NSF Mod.		
Strength at Yield		ppi	132
Strength at Break		ppi	228
Strain at Yield		percent	13
Strain at Break		percent	560
Tear Resistance	ASTM D1004	lbs	45
Puncture Resistance	FTMS 101C, Method 2065	lbs	78

Property	Test Method	Units	MARV
The following parameters shall be tested at the frequency the Manufacturer and Owner agree upon (not less than one sample per railcar of resin):			
Brittleness Temperature	ASTM D746 B, Pass	°F	-76 max
ESCR	ASTM D1693, NSF Mod.	hours	1,500
Dimensional Stability	ASTM D1204, NSF Mod.	percent	1.5 max

2.03 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall properly deliver, unload, and store the HDPE liner in such a manner as to prevent damage to the HDPE liner.
- B. The HDPE liner material shall be protected during storage to prevent material degradation.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Anchoring
 1. The liner shall be anchored at the top of the slope in a trench and shall runout at the slope toe as shown on the Drawings.
 2. The anchor trench shall be excavated to the lines and grades shown on the Drawings, prior to HDPE liner placement.
 3. The anchor trench shall be backfilled after placement of the HDPE liner and overlying geotextile and compacted as soon as possible with hand-operated equipment.
 4. Care shall be taken when backfilling the trenches to prevent any damage to the HDPE liner.
 5. Slightly rounded corners will be provided in trenches where the geomembrane adjoins the trench to avoid sharp bends in the liner. Loose soil shall not underlie the geomembrane in the trenches. Seaming shall continue through the anchor trench.

B. HDPE Liner Placement:

1. Field Panel Identification:

- a. Each field panel shall be given an "identification code" consistent with the layout plan. This code shall be as simple and logical as possible.
- b. Seams shall be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams shall be minimized. Horizontal seams shall not be greater than 5 feet from the toe of slopes, or area of potential stress concentration, unless otherwise authorized.

2. Panel Placement:

a. Location:

- (1) Field panels shall be installed at the locations indicated in the layout plan or as modified by the Engineer.

b. Installation Schedule:

- (1) Field panels shall be placed one at a time, and each field panel shall be seamed immediately after its placement unless otherwise approved by the Engineer.
- (2) In no event shall more panels be placed than can be seamed during the working hours of the day they are placed.
- (3) Overlaps shall be shingled downslope to facilitate drainage.

3. HDPE Liner Deployment:

- a. HDPE liner placement shall not proceed at a sheet temperature below 5 degrees C (40 degrees F) or above 40 degrees C (104 degrees F) for extrusion welding and 60 degrees C (140 degrees F) for fusion welding, during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds that might affect proper placement.

b. HDPE Liner placement shall follow these guidelines:

- (1) Equipment used shall not damage the HDPE liner by any means.
- (2) Personnel working on the HDPE liner shall not smoke, wear damaging shoes, or engage in other activities that could damage the HDPE liner.
- (3) The method used to unroll the panels shall not cause scratches or crimps in the HDPE liner and shall not damage the supporting soil.
- (4) The method used to place the panels shall minimize wrinkles.
- (5) Sandbags shall be placed to prevent the HDPE liner from being uplifted by wind. In case of high winds, continuous loading is recommended along the edges of panels to minimize risk of wind flow under panels.
- (6) The HDPE liner in high traffic areas shall be protected by geotextiles, extra HDPE liner, or other materials.

c. Seams shall be oriented longitudinally with the slopes (i.e., positioned up and down slopes).

d. The prepared surface underlying the geomembrane shall not have deteriorated since previous acceptance and still be acceptable immediately prior to geomembrane placement.

4. HDPE Liner Seaming:

a. Overlapping and temporary bonding requirements are as follows:

- (1) The panels of HDPE liner shall be overlapped by a minimum of 3 inches for extrusion welding or 5 inches for fusion welding, but in any event sufficient overlap will be provided to allow peel tests to be performed on the seam.
- (2) The procedure used to temporarily bond adjacent panels together shall not damage the HDPE liner; the temperature of any spot welding apparatus shall be controlled such that the HDPE liner is not damaged.

- b. Seams shall be prepared in accordance with the following requirements.
- (1) Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, and foreign material.
 - (2) If seam overlap grinding is required, the process shall be completed according to the manufacturer's instructions and in a way that does not damage the HDPE liner.
 - (3) The electric generator is placed on a flat smooth base and a rub sheet such that no damage occurs to the geomembrane.
 - (4) A smooth insulating plate or fabric is placed beneath the hot seaming apparatus after usage.
 - (5) A rub sheet must be used to protect the liner while cutting any materials.
 - (6) No abrading is visible when welding is complete.
 - (7) No metal objects that could potentially damage the liner are permitted for use on the lined area.
 - (8) No "fish mouths" shall be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and an overlap fusion weld shall be applied. All welds on completion of the work shall be tightly bonded. Any liner area showing injury caused by excessive scuffing, puncture, or distress for any cause shall be replaced or patched.
- c. Approved processes for field seaming are extrusion welding and fusion welding. All production seams shall be fusion welded with extrusion welding only being used for detail and patch work as approved by the Engineer. Only apparatuses that have been specifically approved by the Engineer (by make and model) shall be used. Welding process requirements are as follows:

(1) Extrusion Process:

- (a) The welding apparatus shall be equipped with gauges that indicate the temperature in the apparatus and at the nozzle.
- (b) The Contractor shall maintain one spare operable seaming apparatus onsite.
- (c) The extruder shall be purged prior to beginning a seam until all heat degraded extrudate has been removed from the barrel.

(2) Fusion Process:

- (a) The fusion welding apparatuses shall be automated, vehicular-mounted devices that produce a double seam with an enclosed space.
- (b) The fusion welding apparatus shall be equipped with gages that indicate its temperatures and pressures.
- (c) The Contractor shall maintain one spare operable seaming apparatus onsite.
- (d) A firm support directly under the seam overlap will be provided.
- (e) A movable protective layer will be used directly below each overlap of HDPE liner that is to be seamed to prevent buildup of moisture between the sheets.

d. Field seaming shall be conducted within the following weather condition requirements:

- (1) Unless authorized in writing by the Engineer, no seaming shall be attempted at a sheet temperature below 5 degrees C (40 degrees F) or above 40 degrees C (104 degrees F) for extrusion welding and 60 degrees C (140 degrees F) for fusion welding. The sheet temperatures shall be measured with the thermometer on the surface of the HDPE liner sheet. Alternative seaming plans (cold weather or hot weather) must

be approved by the Michigan Department of Natural Resources.

(2) The HDPE liner shall be dry and protected from wind.

e. The Contractor will retain all ownership and responsibility for the HDPE liner until accepted by the Engineer.

5. Defects and Repairs:

a. Repair Procedures:

(1) Tears or pinholes, blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches or seaming as determined by the Engineer.

(2) Surfaces of HDPE that are to be patched shall be prepared to the manufacturer's specifications.

(3) Wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut wrinkles will be seamed and any portion where the overlap or round patch of the same liner extending a minimum of 6 inches beyond the cut in all directions.

(4) Patches shall be round or oval in shape, made of the same HDPE liner and extended a minimum of 6 inches beyond the edge of defect or repair.

(5) Patches shall be applied using approved seaming methods.

b. Seam Reconstruction Procedures:

(1) Seam reconstruction for the extrusion welding process shall be achieved by grinding the existing seam and rewelding a new seam.

(2) Seam reconstruction for the fusion process shall be achieved by applying a new strip of geomembrane along the length of a delineated faulty seam. The cap-strip shall extend at least 6 inches beyond the limit of the seam and the edges will be extrusion seamed to the underlying geomembrane.

c. Replacement Procedures:

- (1) The faulty seam is cut out and a replacement strip is welded in its place.

END OF SECTION

DIVISION 2 - SITE WORK

SECTION 02282 - GEOCOMPOSITE DRAINAGE NET

PART 1 - GENERAL

1.01 SCOPE

- A The Contractor shall provide all labor, materials, and equipment necessary for the furnishing and installation of the geocomposite drainage net which consists of a heat-bonded geotextile/high density polyethylene (HDPE) drainage net composite for placement in the Stage 2 final cover as described herein. All materials used shall meet the requirements of these Specifications, and all work shall be performed in accordance with the procedures provided herein and with all project lines, grades, cross sections, and dimensions shown on the Drawings.

1.02 RELATED SECTIONS

- A Section 01300 - SUBMITTALS
- B Section 02200 - EARTHWORK

1.03 REFERENCE STANDARDS

- A American Society for Testing and Materials (ASTM):
 - 1. ASTM D413 - Test Method for Rubber Property - Adhesion to Flexible Substrate.
 - 2. ASTM D1238 - Test Method for Flow Rate of Thermoplastics by Extrusion Plastometer.
 - 3. ASTM D1505 - Test Method for Density of Plastics by the Density-Gradient Technique.
 - 4. ASTM D1603 - Test Method for Carbon Black in Olefin Plastics.
 - 5. ASTM D1777 - Test Method for Measuring Thickness of Textile Materials.
 - 6. ASTM D3776 - Test Method for Mass Unit Area (Weight of Woven Fabric).
 - 7. ASTM D3786 - Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabric: Diaphragm Bursting Strength Tester Method.

8. ASTM D4491 - Test Methods for Water Permeability of Geotextiles by Permittivity.
9. ASTM D4533 - Test Method for Trapezoid Tearing Strength of Geotextiles.
10. ASTM D4632 - Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).
11. ASTM D4716 - Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
12. ASTM D4751 - Test Method for Determining Apparent Opening Size of a Geotextile.
13. ASTM D4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
14. ASTM D5035 - Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Test).
15. ASTM D5199 - Test Method for Measuring Horizontal Thickness of Geotextiles and Geomembranes.
16. ASTM D5261 - Test Method for Measuring Mass Per Unit Area of Geotextiles.

1.04 SUBMITTALS

- A. The Contractor shall submit the following under the provisions of Section 01300 - SUBMITTALS:
 1. Product Data:
 - a. Manufacturer's descriptive literature and specifications covering the product specified, including installation information.
 2. Certificates of Conformance:
 - a. Manufacturer's certification that the geocomposite drainage net will be manufactured in accordance with specified reference standards.

3. Product Sample:

- a. A representative sample of the geocomposite drainage net suitable for testing.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

- 1. The geocomposite drainage net shall be manufactured by heat-bonding the geotextile to both sides of the HDPE drainage net as shown on the Drawings. No glue, adhesive, or other foreign substance shall be permitted. No product exhibiting burned through geotextiles shall be permitted.
- 2. The geocomposite drainage net shall be manufactured to exhibit a bond between the HDPE drainage net and the geotextile, which shall have a minimum strength greater than or equal to 2 pounds per inch in accordance with ASTM D413.

B. Physical Properties:

- 1. The geocomposite drainage net shall meet or exceed the following criteria:
 - a. HDPE Drainage Net:
 - (1) The HDPE drainage net shall be manufactured by extruding two sets of polyethylene strands to form a three dimensional structure to provide planet water flow. The resin shall be selected to provide an optimum combination of strength, environmental resistance, and resistance to high compressive loads that might reduce transmissivity.
 - (2) The HDPE drainage net shall contain stabilizers to prevent ultraviolet light degradation.
 - (3) The HDPE drainage net shall be Poly-Net 3000 as manufactured by the National Seal Company or Engineer approved equal. The HDPE drainage net shall meet or exceed the following minimum properties:

Property	Test Method	Unit	Value
Resin Density	ASTM D1505	g/cm ³	.940
Resin Melt Index	ASTM D1238	g/10 min	1.0 max.
Carbon Black Content	ASTM D1603	%	2
Thickness	ASTM D5199	inches	0.200
Mass Per Unit Area	ASTM D5261	lbs/ft ²	0.162
Transmissivity at 15,000 psf	ASTM D4716*	m ² /sec	1 x 10 ⁻³
Tensile Strength Machine Direction	ASTM D5035	lbs/in	42

* Per ASTM D4716, the transmissivity was measured using water @ 20°C (68°F) with a gradient of one, between two steel plates, after 1 hour. Value may vary, based on dimensions of the transmissivity specimen and specific laboratory.

(4) National Seal Company
Farnsworth Center
1245 Corporate Boulevard
Suite 300
Aurora, Illinois 60504
Telephone: (800) 323-3820
(708) 898-1161

b. Geotextile Filter Fabric:

- (1) The geotextile filter fabric shall be Trevira 1125 as manufactured by Hoechst Celanese or Engineer approved equal. The geotextile filter fabric heat-bonded to the HDPE drainage net shall be a nonwoven, needlepunched polyester fabric which meets or exceeds the following minimum properties:

Fabric Property	Unit	Test Method	Value
Fabric Weight	oz/yd ²	ASTM D3776	7.1
Thickness, t	mils	ASTM D1777	95
Grab Strength	lbs	ASTM D4632	210
Grab Elongation	%	ASTM D4632	60
Trapezoid Tear Strength	lbs	ASTM D4533	75
Puncture Resistance	lbs	ASTM D4833	95
Mullen Burst Strength	psi	ASTM D3786	360
Water Flow Rate	gpm/ft ²	ASTM D4491	110
Permittivity, ψ	sec ⁻¹	ASTM D4491	1.47
Permeability, $k = \psi t$	cm/sec	ASTM D4491	0.35
Apparent Opening Size (AOS)	sieve size mm	ASTM D4751	70 0.210

(2) Hoechst Celanese Corporation
P.O. Box 5887
Spartanburg, South Carolina 29304-5887
Telephone: (800) 845-7597
(803) 579-5007

2.02 SHIPMENT AND STORAGE

- A. During shipment and storage, the Contractor shall protect the geocomposite drainage net from ultraviolet light exposure, precipitation, snow or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Rolls shall be wrapped in plastic sheets or otherwise protected. Wrappings protecting the rolls shall be removed less than 1 hour prior to unrolling the geocomposite drainage net.
- B. The geocomposite drainage net shall not be exposed to precipitation prior to being installed. During cold weather, geocomposite drainage nets must be protected from freezing.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Subgrade Preparation:

1. Installation of the geocomposite drainage net shall not begin until a proper subgrade has been prepared as indicated in Section 02200 - EARTHWORK and approved by the Engineer. The prepared surface shall be free from loose earth, exposed rocks larger than 1/2 inch in diameter, rubble, and other foreign matter.
2. The surface upon which the geocomposite drainage net is to be placed shall be free of standing water and maintained in a firm, clean, and smooth condition during installation.

B. Geocomposite Drainage Net Handling and Placement:

1. The Contractor shall keep the geocomposite drainage net clean and free of debris prior to installation. If the geocomposite drainage net is not free of soil and debris before installation, it shall be cleaned by the Contractor just prior to installation. During placement, the Contractor shall take care not to entrap dirt or excessive dust into the geocomposite drainage net that could cause clogging of the drainage system, and/or stones that could damage adjacent materials.
2. On slopes, the geocomposite drainage net shall be anchored into the trench as shown on the Drawings.
3. The Contractor shall handle all geocomposite drainage net rolls in a manner which will ensure against damage in any form, and the following shall be complied with:
 - a. The geocomposite drainage net shall be placed as shown on the Drawings.
 - b. On slopes, the geocomposite drainage net shall be secured in the anchor trench, and then rolled down the slope in such a manner as to continually keep the geocomposite drainage net in tension. If necessary, the geocomposite drainage net shall be positioned by hand after being unrolled to minimize wrinkles.

- c. The geocomposite drainage net shall not be placed across the slope (in the horizontal direction), unless otherwise approved by the Engineer.
- d. In the presence of wind, all geocomposite drainage nets in place shall be weighted with sandbags filled with fine grained material or the equivalent.
- e. Geocomposite drainage nets shall be cut using a hook blade or other tool approved by the Engineer.
- f. A visual examination of the geotextile component of the geocomposite drainage net shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects are present.

C. Seams and Overlaps:

- 1. Adjacent rolls shall be overlapped at least 6 inches with the geotextile overlap at least 3 inches and butt ends shall be overlapped at least 2 feet. These overlaps shall be secured by plastic ties approximately every 5 feet along the roll length, every 6 inches in the anchor trench, and every 6 inches along end-to-end seams. Plastic ties shall be white or other bright color for easy inspection. Metallic ties shall not be allowed. If self-locking plastic tie wraps are used, the locking joint shall be set within the rib to prevent damage to adjacent materials. After securing the drainage net, the geotextile shall then be continuously sewn as per the manufacturer's recommendations.
- 2. No horizontal seams shall be allowed on side slopes (i.e., seams shall be along, not across the slope), except as part of a patch or unless otherwise approved by the Engineer.

D. Defects and Repairs:

- 1. Any hole or tear in the geocomposite drainage net shall be repaired by placing a patch extending 2 feet beyond the edges of the hole or tear. The patch shall be secured to the original geocomposite drainage net by tying the drainage net every 6 inches and sewing the geotextile all around, unless otherwise approved by the Engineer. If the hole or tear width across the roll is more than 50 percent of the width of the roll, the damaged area shall be cut out and the two portions of the geocomposite drainage net shall be joined as indicated in Section 3.01.C.

E. Placement of Cover Material:

1. The Contractor shall place all cover materials located on top of geocomposite drainage net as described in Section 02200 - EARTHWORK.

END OF SECTION

Attachment 2
Versar's Construction Quality Control Plan
Section 4.3.

- ▶ Topsoil for vegetation layer
 - Top soil layer will be continuously visually inspected while being spread. A minimum of five lift depth checks will be made per acre.
- ▶ Field Surveys
 - Field surveys will be performed to assure proper lift and total layer thicknesses, and construction at the proper locations and elevations. Survey data will be collected at points a maximum of 50 feet apart, or a minimum of six points per lift, and at any critical location. Survey data will meet a maximum tolerance of ± 0.10 feet horizontally and vertically.

Geosynthetic Installation

HDPE Liner

- ▶ Personnel performing seaming operations will be qualified by experience or by successfully passing seaming tests. At least one seamer will have experience seaming a minimum of 1,000,000 ft² of HDPE geomembrane using the same type of seaming equipment that is used at the site;
- ▶ Versar will provide the Engineer with a list of proposed seaming personnel and their professional records. Proposed personnel deemed sufficiently inexperienced will not be accepted by the Engineer;
- ▶ Test seams will be made on pieces of geomembrane liner to verify that seaming conditions are adequate. Test seams will be made at the beginning of each seaming period and at least once each 4 manhours for each seaming apparatus used that day. Each seamer will make at least one test seam each day;
- ▶ Test seam samples will be at least 2 feet long and 1 foot wide with the seam centered lengthwise. Two adjoining specimens 1 inch wide will be cut from the test seam sample. These specimens will be tested in the field in shear and peel, respectively, by hand or tensiometer, and will not fail in the seam. If a test seam fails, the entire operation will be repeated. If the additional test seam fails, the seaming apparatus or seamer will not be accepted or be used for seaming until two consecutive successful test seams are achieved;
- ▶ Versar will nondestructively test all field seams over their full length using a vacuum test unit or air pressure (fusion process). Testing will be done as the work progresses, and not at the completion of all field seaming;

- ▶ Locations where seams cannot be nondestructively tested will be observed by the CS and SQCO for uniformity and completeness;
- ▶ Vacuum testing procedures and requirements consist of the following:
 - Vacuum testing will be conducted by utilizing a steel box with a clear-view glass top, a rubber gasket on the open bottom perimeter, a pressure gauge on the inside, and a vacuum hose connection to a steel vacuum tank and pump assembly equipped with a rubber pressure/vacuum hose with fittings and connections.
 - The box will be placed over a seam section that has been thoroughly saturated with a soapy water solution. The rubber gasket on the bottom perimeter of the box will fit snugly against the soaped seam section of the liner.
 - When 3 to 5 inches of vacuum is achieved, the seam will be inspected for pinholes, porosity, or nonbonded areas. Test time will be a minimum of 30 seconds per test section.
 - If a void is detected, it will be properly marked for subsequent repairs.
- ▶ Air pressure testing procedures and requirements are as follows:
 - An air pump will be equipped with a pressure gauge capable of generating and sustaining 25 to 30 psi pressure, a hose, fittings and connections, and a sharp needle or approved alternate device.
 - Seams will be sealed. The needle will be inserted in the cavity created by the fusion weld, and 25 to 30 psi pressure will be applied for 5 minutes.
 - The seam will be inspected for defects, pinholes, porosity, and nonbonded areas.
 - If a void is detected, it will be marked and repaired.
- ▶ Destructive seam testing will be performed as follows:
 - Location and Frequency
 - No less than an average of one test will be conducted per 500 feet of seam length or per day, whichever is greater.

- Additional test locations will be determined during seaming at the discretion of the CS and SQCO. Selection of such additional locations will be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.
- Contractor personnel will not be informed in advance of the locations where the seam samples will be taken.
- Sampling Procedures
 - Samples will be cut at locations designated by and under the observation of the SQCO in order to obtain laboratory tests results prior to completion of liner installation. Each sample will be numbered, and the sample number and location will be identified on the panel layout drawing.
 - Holes in the geomembrane resulting from destructive seam sampling will be immediately repaired. The new seams in the repaired area will be nondestructively tested.
- Size of Samples
 - Samples will be 12 inches wide by 38 inches long with the seam centered lengthwise. One 1-inch wide strip will be cut from each end of the sample, and these strips will be tested in the field, by hand or tensiometer, for shear and peel, respectively and will not fail in the seam. The remaining sample will be cut into three equal parts (minimum 12 inches each) and distributed as follows:
 - One portion for the Contractor's independent laboratory testing (12 inches by 12 inches);
 - One portion for the QCM's independent laboratory testing (12 inches by 12 inches); and
 - One portion for the QCM for archive storage (12 inches by 12 inches).
- Contractor's Laboratory Testing
 - Test results from the Contractor's independent laboratory will be submitted to the Engineer as soon as they become available.

- Procedures for Destructive Test Failure

- The following procedures will apply whenever a sample fails the field destructive test or the laboratory test (Contractor's independent or QCM's independent laboratory):
 - Contractor will reconstruct the seam between the failed location and any passed test locations;
 - Contractor will retrace the welding path to an intermediate location (at a 20-foot minimum from location of a failed test) and take a small sample for an additional field test. If this additional sample passes the test, the seam will be reconstructed between that location and original failed location. If this sample fails, the process will be repeated;
 - In any case, all acceptable seams will be bounded by two passed test locations in both directions, and one sample for destructive testing will be taken within the reconstructed area; and
 - Whenever a sample fails, additional testing may be required for seams that were welded by the same welder and welding apparatus or welding during the same time shift.

Geotextiles - The SQCO will ensure that the geotextile separate sheets are indeed sewn together with a minimum of 4-inch overlap. The SQCO will lightly tug on the seams at various locations to verify that all seams have indeed been sewn, and the stitch is at least as strong to the pull as the fabric itself. The SQCO will notify the QCM of any problems.

All holes or tears in the geotextile will be repaired by patching with the same geotextile. The patch will be a minimum of 12 inches larger in all directions than the area to be repaired and will be sewn into place. On slopes steeper than 20 percent, the patch may not be placed any closer than 1 inch (25 mm) from any edge. If a roll has a tear which exceeds 10 percent of the width of the roll, that portion of the roll will be removed and replaced.

The SQCO will observe all repairs and verify that each conforms with the above procedures. The SQCO will notify the QCM and the CM of any problems or deviations from the specified procedures.

The cover material will be placed in such a manner to assure that the geotextiles are not damaged. Care will be taken to minimize any slippage of the geotextile and to assure that no tensile stress is induced in the materials.

4.3.3 Geocomposite Drainage Net

Manufacturers Documentation

Prior to delivery, the Geocomposite Drainage Net Manufacturer will provide documentation which demonstrates that the material properties of the material meet design requirements. Delivered rolls of geocomposite drainage net will be appropriately labeled.

Certification of Material Properties

Prior to the installation of any geocomposite, the Geocomposite Manufacturer or Installer will provide the CS with the following information:

- ▶ The origin (supplier's name and production plant) and identification (brand name and number) of the geotextile and HDPE drainage net used to fabricate the geocomposite; and
- ▶ Copies of dated quality control certificates issued by the geotextile and HDPE drainage net supplier. These certificates will contain the results of the quality control tests performed on the geocomposite components as outlined in this CQCP.

The Geocomposite Drainage Net Manufacturer will provide the CS with a list of guaranteed "minimum average roll value" properties (as defined by Radian International) for the type of geocomposite drainage net to be supplied. The Geocomposite Drainage Net Manufacturer will provide the CS with a written certification signed by a responsible party that the geocomposite drainage net actually delivered has properties which meet or exceed the guaranteed "minimum average roll values" properties.

The SQCO will examine the Manufacturer's certifications to verify that the property values listed on the certifications meet or exceed the Manufacturer's guaranteed minimum values and the design specifications. Deviations will be reported to the CS and CM.

Labeling

The Geocomposite Drainage Net Manufacturer will identify all rolls of geocomposite drainage net. Each roll will have a weatherproof label which contains the following:

- ▶ Manufacturer's name,
- ▶ Product identification, and
- ▶ Roll dimensions.

In addition, if any special handling of the geocomposite drainage net is required, it will be so marked on the top surface of the geotextile (e.g., "This Side Up").

The SQCO will examine rolls upon delivery, and any deviation from the above requirements will be reported to the CS and CM.

4.3.4 Shipment and Storage

During shipment and storage, the geocomposite drainage net will be protected from ultraviolet light exposure, precipitation, snow, or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Rolls will be wrapped in plastic sheets or otherwise protected. Wrappings protecting the rolls will be removed less than 1 hour prior to unrolling the geocomposite drainage net.

Geotextiles/geonet composites will not be exposed to precipitation prior to being installed. Wet geotextiles/geonet composites are heavy, which makes them difficult to deploy and can also effect liner welding when the geomembrane is adjacent to the geotextile. During cold weather, geotextiles/geonet composites will be protected from freezing.

The SQCO will observe rolls upon delivery and prior to installation. Any deviation from the above requirements will be reported to the CS and CM. Any damaged rolls will be rejected and replaced at no cost to the Owner.

4.3.5 Conformance Testing of Geocomposite Drainage Nets

Prior to the deployment of the rolls, the SQCO will remove and forward samples to the Geosynthetics QA Laboratory for testing to verify conformance with the test methods and values presented in Appendix B.

Sample Collection

Using the packing list provided by Manufacturer or a sequential inventory list made by the SQCO, rolls will be selected for sampling at a minimum frequency of 1 sample per 100,000 square feet (9,000 m²) of material. If the material is shipped in identifiable lots or manufacturing runs, sample selection will be adjusted to assure that the minimum frequency is met and that each different lot or manufacturing run is represented by at least one sample. If a roll is not identifiable by roll number, the SQCO will inform the CS immediately. If the roll cannot be tracked, the CS will reject the roll.

Samples will be taken across the entire width of the roll and will not include the first 3 lineal feet (1 m). Unless otherwise specified, samples will be 3 feet (1 m) long by the roll width. The SQCO will mark the machine direction on the samples with an arrow.

Test Results

The results of the conformance testing will be evaluated in accordance to the following procedure:

- ▶ If the average test values for the sample meet all of the values given in the design specifications and the Manufacturer's guaranteed minimum values, the sample passes;
- ▶ If the average test value for the sample does not meet one or more of the required values, additional evaluation procedures will be implemented by the SQCO. Additional tests required for further evaluation will be done at no expense to the Owner and will proceed as follows.
 - For the failing parameter(s), two additional tests will be performed on the sample. These tests may be performed by another Geosynthetics QA Laboratory at the discretion of the SQCO and the CM.
 - If the average test values for each of the two additional tests meet the required values, the roll and adjacent rolls pass and are acceptable.
 - If one or more of the average test values do not meet requirements, the roll will be rejected, and samples will be collected from the closest numerical roll on both sides of the failed roll. These samples from the closest numerical roll will be tested for the failed parameter(s). If one or both of these tests do not meet requirements that (those) roll(s) will be rejected, and the SQCO and CM will determine further testing protocol and criteria for identifying the limits of rejected rolls.

4.3.6 Handling and Placement

The Installer will handle geotextiles/geonet composites in such a manner as to minimize damage and will comply with the following:

- ▶ On slopes, the geocomposite will be securely anchored and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite will be positioned by hand after being unrolled to minimize wrinkles;
- ▶ In the presence of wind, all geocomposites will be weighted with sandbags filled with fine grained material or the equivalent. Sandbags will be installed during deployment and will remain until replaced with cover material;

- ▶ Unless otherwise specified, single-sided geocomposite will not be welded to the geomembrane;
- ▶ Geocomposites will be cut using a hook blade or other tool approved by the CS. If in place, special care will be taken to protect underlying geosynthetics from damage that could be caused by the cutting of the geocomposite. Care will be taken not to leave the tools in the geocomposite;
- ▶ The Installer will take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite;
- ▶ During placement of geocomposite, care will be taken not to entrap, in or beneath the geocomposite, stones or dirt that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming; and
- ▶ A visual examination of the geotextile component of the geocomposite will be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects are present.

The SQCO will note any noncompliance and report it to the CS and CM.

4.3.7 Seams and Overlaps

In general, no horizontal seams will be allowed on sideslopes. Consequently, seams will be along, not across, the slope, except as part of a patch. If horizontal seams are required, adjacent horizontal seams will be offset.

At a minimum, the following requirements will be met:

- ▶ Adjacent geocomposite will be overlapped so that the HDPE drainage net overlaps by at least 6 inches (150 mm) and the geotextile of the geocomposite overlap by at least 3 inches (75 mm);
- ▶ The HDPE drainage net of the geocomposite will have overlaps and will be tied with plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices will not be allowed. If self-locking plastic tie wraps are used, the locking joint will be set within the rib to prevent damage to adjacent materials;
- ▶ Tying will be every 5 feet (1.5 m) along the slope, every 6 inches (150 mm) in the anchor trench, and every 6 inches (150 mm) along end-to-end seams on the base of the fill;

- ▶ In the corners of the sideslopes where overlaps between perpendicular strips are required, an extra layer will be unrolled along the slope, on top of the previously installed geocomposite, from top to bottom of the slope;
- ▶ When more than one layer of geocomposite is installed, joints will be staggered;
- ▶ Once HDPE drainage net is tied, the geotextile of the geocomposite will be seamed. The Installer will pay particular attention to seams to ensure that no earth cover material could be inadvertently inserted beneath the geotextile, if applicable; and
- ▶ Any sewing will be done using polymeric thread with physical, chemical, and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Sewing will be done using machinery and stitch types specified in the project specifications, or as approved in writing by the CM and the SQCO.

The SQCO will note any deviation and report it to the CS and CM.

4.3.8 Repair Procedures

The final decision as to the appropriate repair will be agreed upon between the CS, Installer, and SQCO. Prior to acceptance of the geocomposite, the Installer will locate and repair all damaged areas as directed by the SQCO. Care will be taken to remove any soil or other material which may have penetrated the torn geotextile. The SQCO will observe any repair and report any noncompliance with the following requirements, in writing, to the CS.

If in the SQCO's judgement, the defect is determined to be small, typically smaller than 3 feet x 3 feet (1 m x 1 m), the geocomposite will be repaired as follows:

- ▶ If the HDPE drainage net is judged to be undamaged but the geotextile is damaged, a patch of geotextile will be placed. The geotextile patch will be sewn in place with a minimum 24-inch (0.6 m) overlap in all directions; and
- ▶ If the HDPE drainage net is judged to be damaged, the damaged HDPE drainage net will be removed. A section of HDPE drainage net will be cut to replace the removed section. The HDPE drainage net will be tied to the existing HDPE drainage net using white plastic fasteners placed at least every 6 inches (150 mm) of overlap. A geotextile patch will be placed over the repaired HDPE drainage net section. The geotextile patch will be thermally bonded in place with a minimum 12-inch (0.3 m) overlap in all directions.

If the hole or tear width across the roll is more than 50 percent of the width of the roll, the damaged area will be cut, and the two portions of the geocomposite drainage net will be joined as indicated in Section 4.3.7.

The SQCO will observe any repair, note any deviation with the above requirements, and report them to the CS and CM.

4.3.9 Placement of Materials on Geocomposite Drainage Nets

The Installer will place materials on the geocomposite drainage net in the following manner:

- ▶ Cause no damage to the geocomposite drainage net and underlying geosynthetics;
- ▶ Allow minimal slippage of the geocomposite drainage net on underlying layers;
- ▶ No excessive stresses in the geocomposite drainage net;
- ▶ Equipment used for placing the overlying material will not be driven directly on the geocomposite drainage net;
- ▶ A minimum thickness of 1 foot (30 cm) of soil will be maintained between light, low ground pressure equipment (such as a wide pad Caterpillar D-6 or lighter) and the geocomposite drainage net;
- ▶ A minimum thickness of 1.5 feet (45 cm) of soil will be maintained between rubber-tired vehicles and the geotextile, unless approved by the Design Engineer and CM; and
- ▶ In heavily trafficked areas, such as access ramps, soil thickness will be at least 3 feet (1 m).

Any deviation will be noted by the SQCO and reported to the CS and CM.

4.3.10 Erosion Control Revetments

The Fabrications Manufacturer will provide materials certification that the properties of the material meet manufacturer's specification. The fabric forms manufacturer will provide the CS with a list of guaranteed minimum properties (as defined by the Technical Specifications). The fabric form manufacturer will provide the CS with written certification signed by a responsible party that the fabric forms actually delivered have properties which meet or exceed the guaranteed properties.

Attachment 3
Liner and Geonet Specifications

TEX-NET® SPECIFICATIONS

GEOCOMPOSITE PROPERTIES				
PROPERTY	TEST	UNITS	MINIMUM ²	
			TN3002/1120	TN3002/1125
Thickness	ASTM D 5199	inch	0.275	0.305
Transmissivity ¹ (15,000 psf)	ASTM D 4716	m ² /sec	5 x 10 ⁻⁵	3 x 10 ⁻⁵
Ply Adhesion	ASTM D 413 or F 904	lb/in	2.0	2.0
Tensile Strength (MD)	ASTM D 4632	lbs	535	580
COMPONENT PROPERTIES ³				
GEONET	TEST	UNITS	PN 3000	
Polymer Density	ASTM D 1505	g/cm ³	0.94	
Polymer Melt Index (Max)	ASTM D 1238	g/10 min	0.5	
Carbon Black Content	ASTM D 4218	%	2.0	
Thickness	ASTM D 5199	inches	0.200	
Mass Per Unit Area	ASTM D 5261	lbs/ft ²	0.162	
Transmissivity ¹	ASTM D 4716	m ² /sec	1x10 ⁻³ @ 15,000 psf	
Tensile Strength	ASTM D 5035	lbs/in	45	
GEOTEXTILE	TEST	UNITS	MINIMUM ²	
			1120	1125
Fabric Weight	ASTM D 5261	oz/yd ²	5.7	7.1
Thickness	ASTM D 5199	mils	75	95
Grab Strength	ASTM D 4632	lbs	160	210
Water Flow Rate	ASTM D 4491	gpm/ft ²	130	110
AOS	ASTM D 4751	Sieve Size	70	70
		mm	0.210	0.210

1. Measured using water @ 20° C (68°F) with a gradient of one, between two steel plates, after one hour. Value may vary, based on dimensions of the transmissivity specimen and specific Laboratory.
2. These values represent minimum acceptable test values for a roll as tested according to NSC/FSI's Manufacturing Quality Control Manual. Individual test specimen values are not addressed in this specification.
3. Component properties are tested prior to the lamination process. They cannot be tested on the final product.

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TEX-NET® SPECIFICATIONS

GEOCOMPOSITE PROPERTIES				
PROPERTY	TEST	UNITS	MINIMUM ²	
			TN3002CN/1120	TN3002CN/1125
Thickness	ASTM D 5199	inch	0.250	0.304
Transmissivity ¹ (4,000 psf)	ASTM D 4716	m ² /sec	8 x 10 ⁻⁵	6 x 10 ⁻⁵
Ply Adhesion	ASTM D 413 or F 904	lb/in	2.0	2.0
Tensile Strength (MD)	ASTM D 4632	lbs	535	580
COMPONENT PROPERTIES ³				
GEONET	TEST	UNITS	PN 3000 CN	
Polymer Density	ASTM D 1505	g/cm ³	0.94	
Polymer Melt Index (Max)	ASTM D 1238	g/10 min	0.5	
Carbon Black Content	ASTM D 4218	%	2.0	
Thickness	ASTM D 5199	inches	0.200	
Mass Per Unit Area	ASTM D 5261	lbs/ft ²	0.150	
Transmissivity ¹	ASTM D 4716	m ² /sec	1x10 ⁻³ @ 4,000 psf	
Tensile Strength	ASTM D 5035	lbs/in	40	
GEOTEXTILE	TEST	UNITS	MINIMUM ²	
			1120	1125
Fabric Weight	ASTM D 5261	oz/yd ²	5.7	7.1
Thickness	ASTM D 5199	mils	75	95
Grab Strength	ASTM D 4632	lbs	160	210
Water Flow Rate	ASTM D 4491	gpm/ft ²	130	110
AOS	ASTM D 4751	Sieve Size	70	70
		mm	0.210	0.210

1. Measured using water @ 20° C (68°F) with a gradient of one, between two steel plates, after one hour. Value may vary, based on dimensions of the transmissivity specimen and specific Laboratory.
2. These values represent minimum acceptable test values for a roll as tested according to NSC/FSI's Manufacturing Quality Control Manual. Individual test specimen values are not addressed in this specification.
3. Component properties are tested prior to the lamination process. They cannot be tested on the final product.

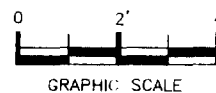
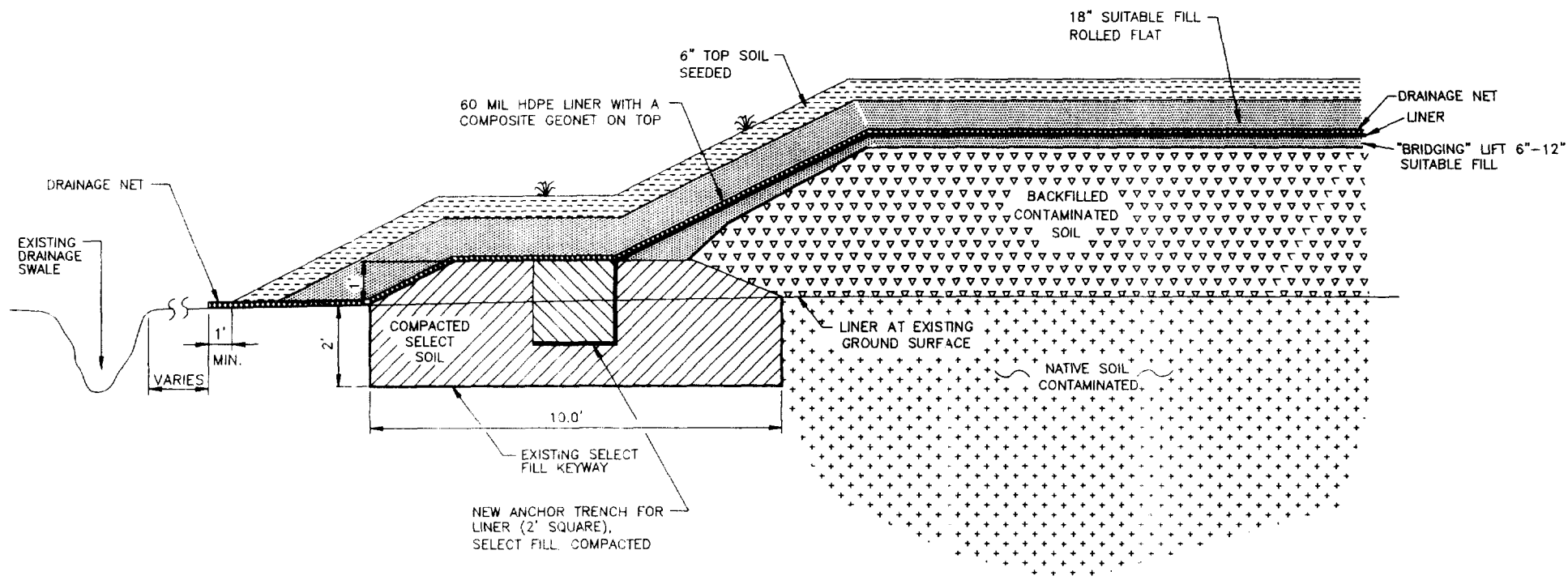
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NSC

NATIONAL SEAL COMPANY
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 Aurora, IL 60504
 (708) 898-1161 • (800) 323-3820
 Fax: (708) 898-3461



Attachment 4
Versar Drawing No. L9809100



1.	REVISED	J.K.	C.G.	09/22/98
NO.	REVISIONS	BY	APP	DATE
ENVIRO-CHEM ZIONSVILLE, INDIANA				
DESIGNED	C. GAFFNEY	DATE	09/10/98	RCRA-COMPLIANT CAP (HDPE DESIGN)
DRAWN	J. KEMLER	DATE	09/14/98	
CHECKED	G. ANASTOS	DATE	09/14/98	
Versar, Inc. 1900 FROST ROAD, SUITE 110 BRISTOL, PA 19007 (215) 788-7844				PROJECT NO. 3709.001 DRAWING NO. L9809100
				SCALE AS NOTED SHEET 1 OF 1